EMPLOYEE

| NAME | DEPT | MGRID | SALARY | BONUS |
|---|---|---|---|---|
| | | | | |

(C1) NAME ≠ NULL
(C2) DEPT = "US*"
(C3) BONUS ≤ 0.4 × SALARY
(C4) FOREIGN KEY (DEPT, MGRID)
REFERENCES MANAGER (DEPT, MGRID)
(C5) (DEPT = "USSales") ⇒ SALARY ≤ MGR
(DEPT, MGRID) . SALARY

EMPLOYEE

| NAME | DEPT | MGRID | SALARY |
|---|---|---|---|
| | | | |

(C6) NAME ≠ NULL
(C7) DEPT = "US*"
(C8) 500 ≤ MGRID ≤ 999
(C9) 100000 ≤ SALARY ≤ 200000

Figure 1

200

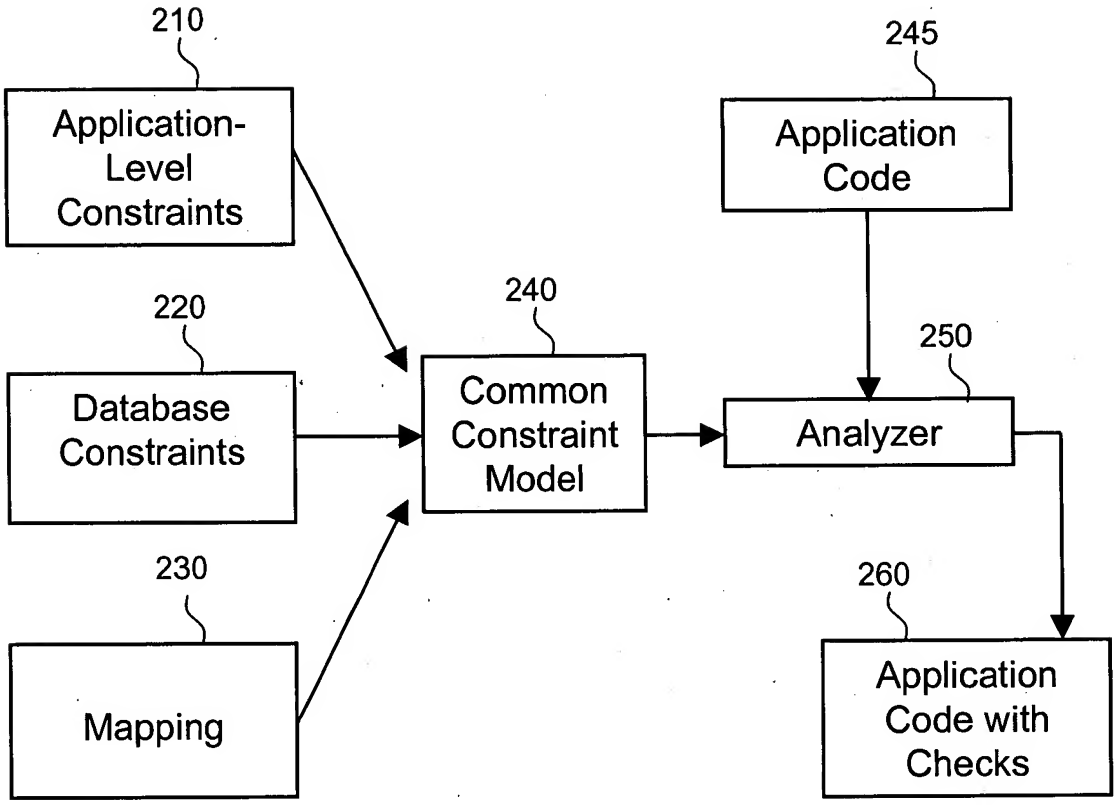
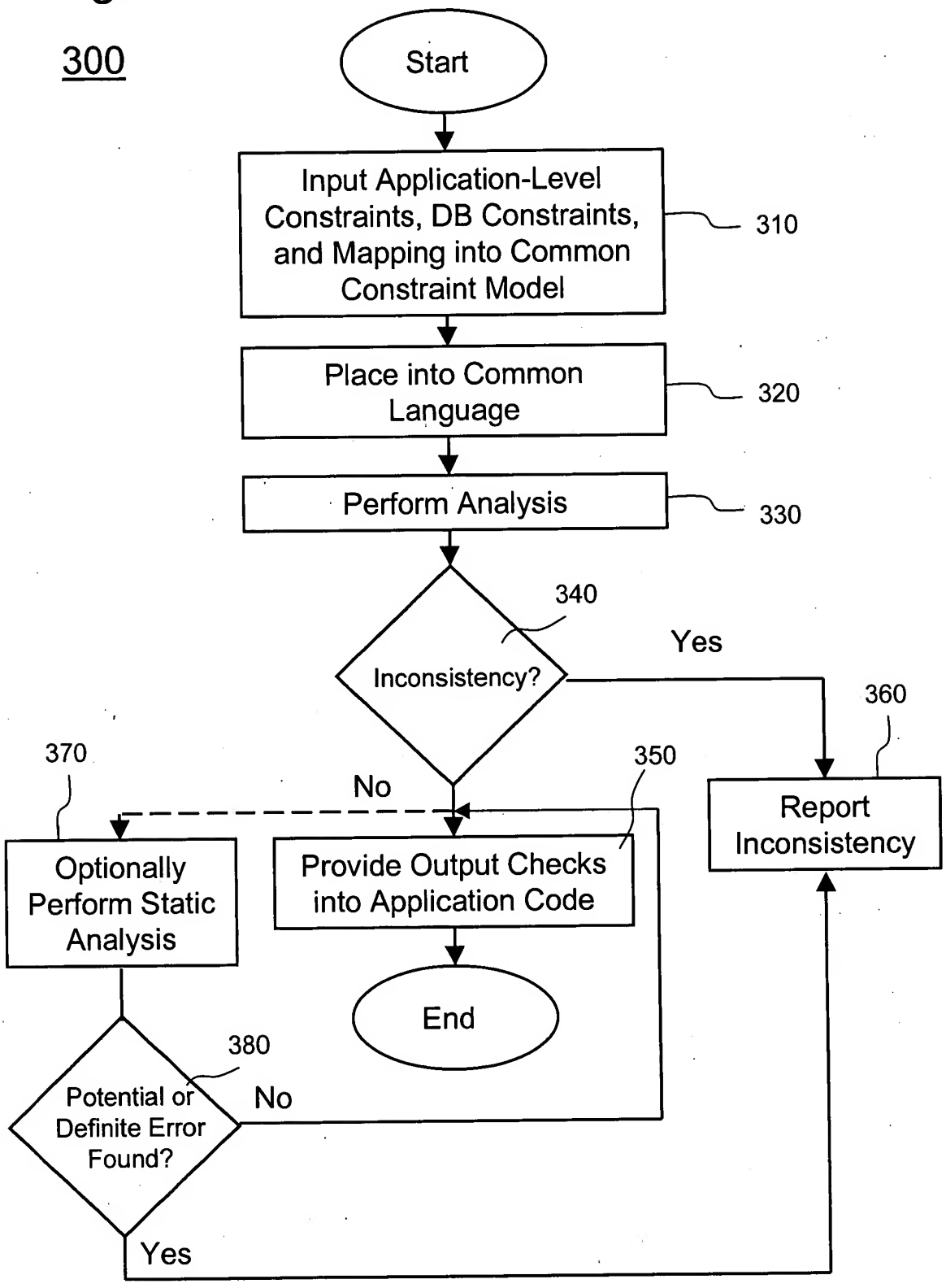

210
Application-Level Constraints
220
Database Constraints
230
Mapping
240
Common Constraint Model
245
Application Code
250
Analyzer
260
Application Code with Checks

Figure 2

Figure 3


300
Start
Input Application-Level Constraints, DB Constraints, and Mapping into Common Constraint Model
310
Place into Common Language
320
Perform Analysis
330
340
Inconsistency?
Yes
360
Report Inconsistency
No
370
350
Optionally Perform Static Analysis
Provide Output Checks into Application Code
End
380
Potential or Definite Error Found?
No
Yes

400

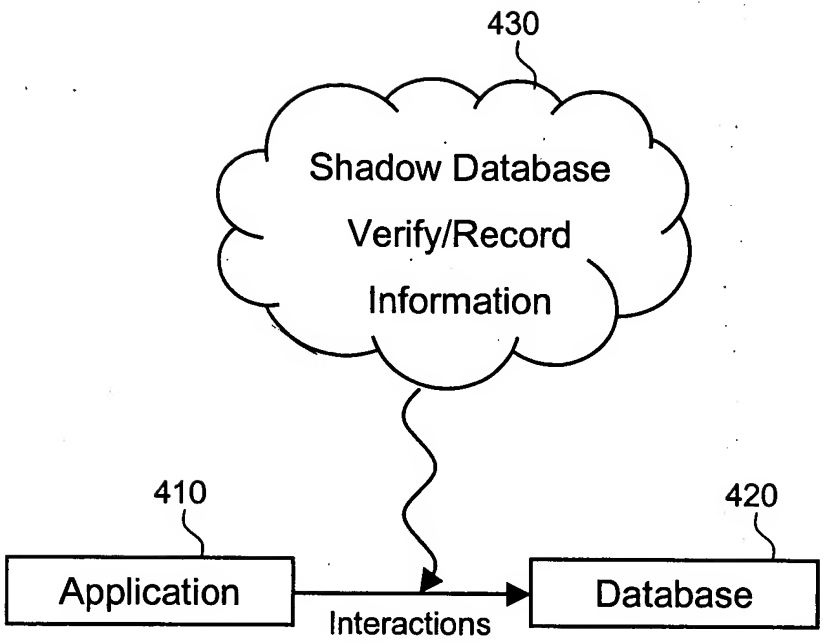

430
Shadow Database
Verify/Record
Information
410
420
Application
Interactions
Database

Figure 4

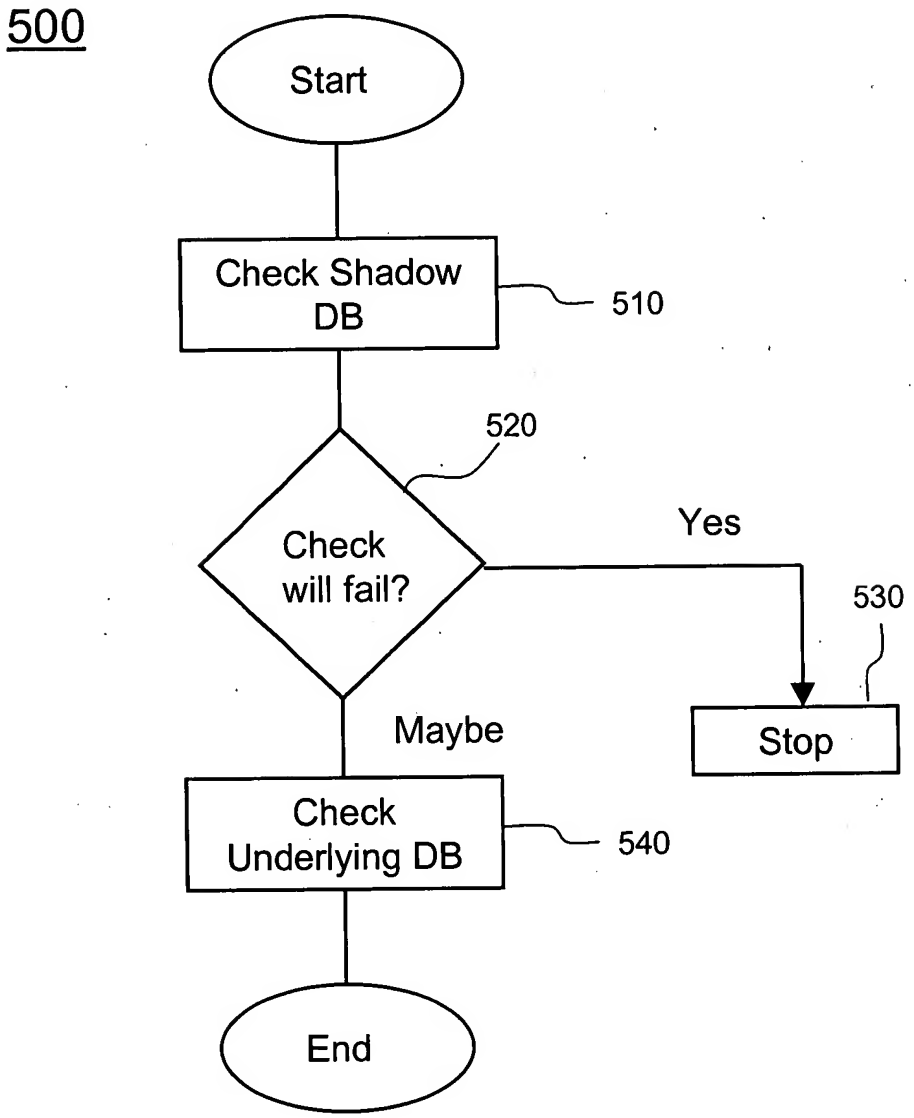

500
Start
Check Shadow DB
510
520
Check will fail?
Yes
530
Stop
Maybe
Check Underlying DB
540
End

Figure 5

```
DISCONNECT ALL;
DROP DB FOO1;
CREATE DB FOO1;
CONNECT TO FOO1;

CREATE TABLE ODED.DCODES(
C CHARACTER(1) NOT NULL,
CHECK(
(C='A') OR (C='B')  OR  (C='C')  OR
(C='D')  OR (C='E')),
PRIMARY  KEY (C)
);


CREATE TABLE ODED.CUSTOMER(
CUSTOMERID BIGINT NOT NULL,
NAME CHARACTER(20) NOT NULL,
CHECK (
(  (CUSTOMERID >= 100000) AND
(CUSTOMERID <= 200000)) OR   (
(CUSTOMERID >= 20000000) AND
(CUSTOMERID <= 40000000)) ),
PRIMARY  KEY (CUSTOMERID) );


ALTER TABLE ODED.CUSTOMER   DATA
CAPTURE CHANGES  NOT VOLATILE;



CREATE TABLE ODED.DISCOUNT(
DISCOUNTCODE CHARACTER(1) NOT NULL,
PERCENT INTEGER NOT NULL,
DELAY INTEGER NOT NULL,
CUSTID BIGINT NOT NULL,
-- CHECK (
-- (AMOUNT>1) AND (AMOUNT <= 100000)),
-- CHECK ((ORDERNUM >= 0) AND (ORDERNUM
<= 10000000)),
CHECK(
((1<= DELAY) AND (DELAY <=7)) OR ((10
<= DELAY) AND (DELAY <= 30)) OR ((45 <=
DELAY) AND (DELAY <= 60))),
CHECK(PERCENT in   (5, 10, 15) OR ((20
<= PERCENT ) AND (PERCENT <= 30))),
CHECK(DISCOUNTCODE in  ('A',
'B','C','D','E')),
PRIMARY  KEY (CUSTID, DISCOUNTCODE),
FOREIGN KEY (CUSTID) REFERENCES
ODED.CUSTOMER (CUSTOMERID) ON DELETE
CASCADE,
FOREIGN KEY (DISCOUNTCODE) REFERI
ODED.DCODES (C)
);

ALTER TABLE ODED.DISCOUNT   DATA
CAPTURE CHANGES  NOT VOLATILE ;


CREATE TABLE ODED.INVENTORY(
ITEMNUMBER CHARACTER(8) NOT NULL,
AMTINSTOCK INTEGER NOT NULL,
CATEGORY VARCHAR(20) NOT NULL,
CHECK (
(AMTINSTOCK  >=0) AND (AMTINSTOCK
<=10000)),
CHECK(
( ( ITEMNUMBER Like 'EU%' ) AND
(ITEMNUMBER > 'EU000000') AND
(ITEMNUMBER < 'EU999999')) OR
( ( ITEMNUMBER Like 'US%' ) AND
(ITEMNUMBER > 'US000000') AND
(ITEMNUMBER < 'US999999')) OR
( ( ITEMNUMBER Like 'WL%' ) AND
(ITEMNUMBER > 'WL000000') AND
(ITEMNUMBER < 'WL999999'))
),
PRIMARY  KEY (ITEMNUMBER) );

ALTER TABLE ODED.INVENTORY   DATA
CAPTURE CHANGES  NOT VOLATILE;



CREATE TABLE ODED.CUSTOMERCATEGOR
CUSTOMERID BIGINT NOT NULL,
CATEGORY VARCHAR(20) NOT NULL,
-- CHECK (
-- (AMTINSTOCK  >=0) AND (AMTINSTC
<=10000)),
PRIMARY  KEY (CUSTOMERID, CATEGORY
FOREIGN KEY (CUSTOMERID) REFERENCE
ODED.CUSTOMER (CUSTOMERID) ON DELE
CASCADE
 );

ALTER TABLE ODED.INVENTORY   DATA
CAPTURE CHANGES  NOT VOLATILE ;

CREATE TABLE ODED.ORDER(
ORDERNUM BIGINT NOT NULL,
CUSTID BIGINT NOT NULL ,
AMOUNT DECIMAL NOT NULL,
TAX DECIMAL NOT NULL,
DISCOUNTCODE CHARACTER(1) NOT NULL
```

Figure 6A

```
CHECK ((AMOUNT>1) AND (AMOUNT <=
100000)),
CHECK ((ORDERNUM >= 0) AND (ORDERNUM <=
10000000)),
CHECK((TAX <= .4 * AMOUNT) AND ((TAX =
25) OR (TAX =50) OR (TAX >=100))),
PRIMARY  KEY (ORDERNUM),
FOREIGN KEY (CUSTID) REFERENCES
ODED.CUSTOMER (CUSTOMERID) ON DELETE
CASCADE,
FOREIGN KEY (DISCOUNTCODE) REFERENCES
ODED.DCODES (C)
);

ALTER TABLE ODED.ORDER   DATA CAPTURE
CHANGES  NOT VOLATILE ;


CREATE TABLE ODED.ORDERDETAILS(
ORDERNUM BIGINT NOT NULL,
ITEM# CHARACTER(8) NOT NULL ,
NOITEMSREQUESTED INTEGER NOT NULL,
NOITEMSSHIPPED  INTEGER NOT NULL,
NOITEMSRECEIVED INTEGER  NOT NULL,
CHECK ((NOITEMSREQUESTED >0) AND
(NOITEMSREQUESTED<101)),
CHECK (NOITEMSRECEIVED <=
NOITEMSSHIPPED),
CHECK(NOITEMSSHIPPED <=
NOITEMSREQUESTED),
PRIMARY  KEY (ORDERNUM, ITEM#),
FOREIGN KEY (ITEM#) REFERENCES
ODED.INVENTORY (ITEMNUMBER) ON DELETE
CASCADE,
FOREIGN KEY (ORDERNUM) REFERENCES
ODED.ORDER (ORDERNUM) ON DELETE CASCADE
);

ALTER TABLE ODED.ORDERDETAILS   DATA
CAPTURE CHANGES  NOT VOLATILE ;


  CREATE TRIGGER CatTrigger
      AFTER INSERT ON
ODED.CUSTOMERCATEGORIES
      REFERENCING NEW AS xxx
      FOR EACH ROW MODE DB2SQL
      WHEN (NOT EXISTS
      (SELECT * FROM ODED.INVENTORY
       WHERE
xxx.CATEGORY=ODED.INVENTORY.CATEGORY
      ))
            SIGNAL SQLSTATE '7599
('Cannot insert category field ')

  CREATE TRIGGER InvTrig1
      AFTER DELETE ON ODED.INVENT
      REFERENCING OLD AS xxx
      FOR EACH ROW MODE DB2SQL
      WHEN (EXISTS
      (SELECT * FROM
ODED.CUSTOMERCATEGORIES
       WHERE
xxx.CATEGORY=ODED.CUSTOMERCATEGOR
TEGORY
      ))
            SIGNAL SQLSTATE '7600
('Cannot delete referenced catego


 insert into ODED.INVENTORY
values('EU123456', 10, 'grinders'
```

Figure 6B

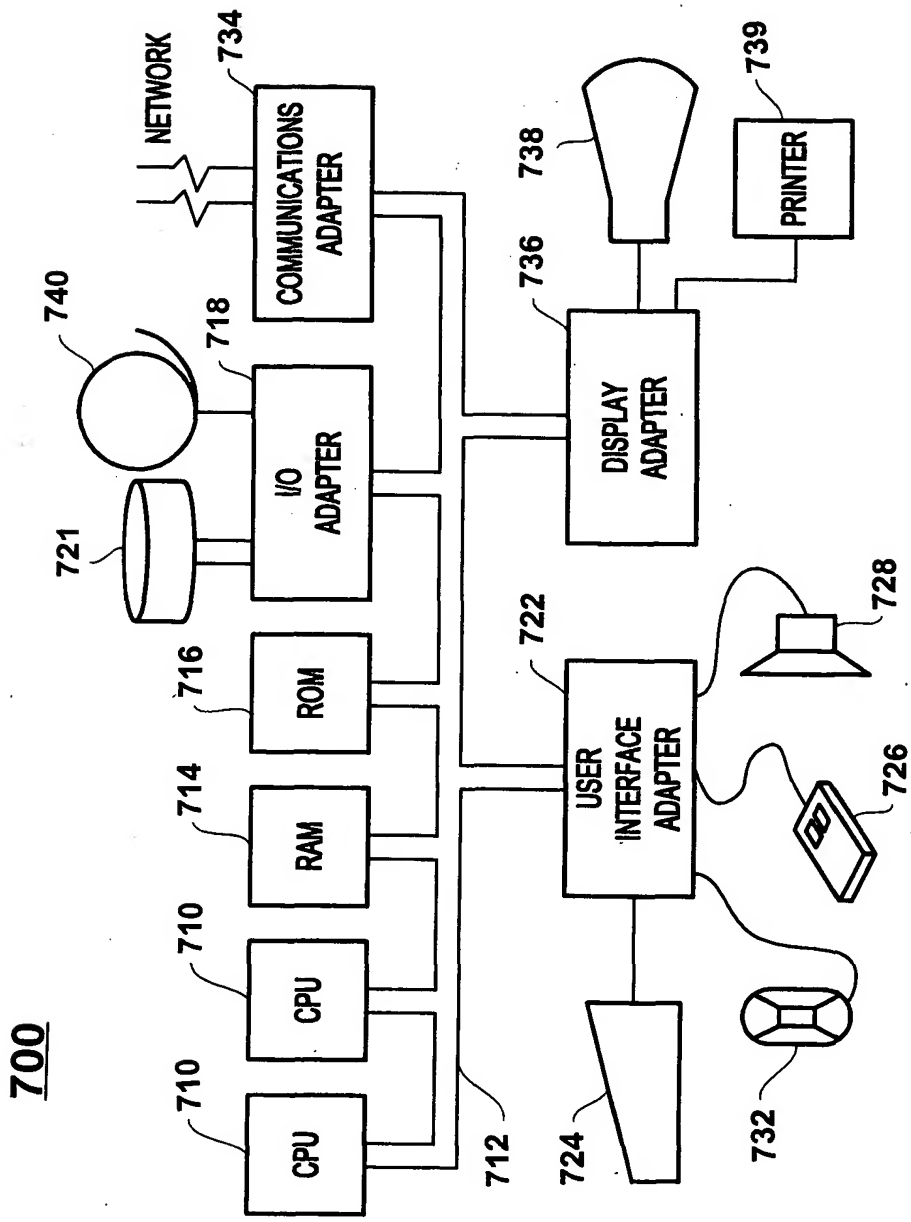



Figure 7

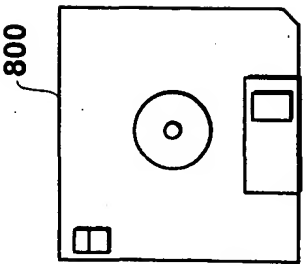



Figure 8